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APPENDIX 20

RP-16 RELOCATABLE OBJECT TEXT

FINAL SOFTWARE REPORT

DATA ITEM NO. A005

**INTEGRATED ELECTRONIC WARFARE SYSTEM
ADVANCED DEVELOPMENT MODEL (ADM)**

PREPARED FOR:

NAVAL AIR DEVELOPMENT CENTER
WARMINSTER, PENNSYLVANIA

CONTRACT N62269-75-C-0070



ELECTROMAGNETIC
SYSTEMS DIVISION

1 OCTOBER 1977

UNCLASSIFIED

APPENDIX 20
RP-16 RELOCATABLE OBJECT TEXT
FINAL SOFTWARE REPORT
DATA ITEM A005

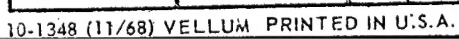
INTEGRATED ELECTRONIC WARFARE SYSTEM (IEWS)
ADVANCED DEVELOPMENT MODEL (ADM)

Contract No. N62269-75-C-0070

Prepared for:
Naval Air Development Center
Warminster, Pennsylvania

Prepared by:
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1 OCTOBER 1977



1.0 SCOPE

1.1 IDENTIFICATION

The Relocatable Object Text Specification is one of three specifications covering the RP-16 Relocatable Macro Assembler/Linking Loader. The overall software package has been assigned Raytheon control number TBD. This document has been assigned a designator, CG-, consistent with Technical Standards 3 and 3050. The authorized abbreviation for the Relocatable Object Text is RAMA text.

1.2 FUNCTIONAL SUMMARY

This specification defines the format of the load module text that is generated by the RAMA assembler and used as input to the linking loader.

2.0 APPLICABLE DOCUMENTS

The following documents, of the exact issue shown, form a part of this specification to the extent specified therein:

- a) RP-16 Microcontroller Manual
- b) Raytheon RP-16 Relocatable Macro Assembler Specification, CG-TBD
- c) RAMA Linking Loader Specification, CG-TBD

3.0 REQUIREMENTS

RP-16 relocatable load modules are stored as one or more records in RP-16 relocatable object text format. Each record consists of 80 bytes and contains the following fields:

1) Record type	1 byte	3) Data field	75 bytes
2) Sequence number	2 bytes	4) Checksum	2 bytes

The record type field contains D2₁₆ (ASCII character 'R') indicating a relocatable object text record. The sequence number starts at 0001 for the first record and is incremented by one for each succeeding record. The data consists of data items each of which is preceded by a 1 byte item type code. The checksum consists of rotate and add of the first 78 bytes, two bytes at a time.

3.1 DATA ITEM TYPES

The data field in each record consists of one or more data items. Each data item has as its first byte an item type code which specifies the number of bytes following and their contents. A data item may not be split between records and any record that is terminated prior to being filled has the remainder of its data field padded with the null item type 00.

3.1.1 ITEM TYPE 00 - NULL ITEM

This item type specifies the end of the data items in the current record. Its length is one byte consisting of only the item type code.

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3.1.2 ITEM TYPE 01 - ENTRY POINT NAME

This item type precedes all other item types except item type 0F in the object text file. It is used only for performing a library search for resolving external references. The item type code is followed by 10 bytes containing up to 10 ASCII characters left justified with blanks appended if necessary.

3.1.3 ITEM TYPE 02 - ABSOLUTE PROGRAM ORIGIN

This item type specifies the absolute core location in which the next data word is to be loaded. The item type code is followed by two bytes containing the absolute core address.

3.1.4 ITEM TYPE 03 - RELOCATABLE PROGRAM ORIGIN

This item type specifies the relocatable core location in which the next data word is to be loaded. This is the offset from the initial location for the load module. The item type code is followed by two bytes containing the relocatable core address. The absolute core address is equal to the sum of the load module base address and the relocatable address.

3.1.5 ITEM TYPE 04 - FILL DATA

This item type specifies the number of consecutive words which are to be filled with the same data. The item type code is followed by 2 bytes containing the number of words to be filled followed by two bytes containing the data.

3.1.6 ITEM TYPE 05 - ABSOLUTE DATA

This item type specifies the data to be placed in the current location. The item type code is followed by two bytes containing the absolute data.

3.1.7 ITEM TYPE 06 - RELOCATABLE DATA

This item type specifies the relocatable data to be placed in the current location. The item type code is followed by two bytes containing a relocatable value. The load module base address is added to the relocatable value and the sum placed in the current location.

3.1.8 ITEM TYPE 07 - ABSOLUTE LOCATION

This item type specifies an absolute location value to be used with a following item type. The item type code is followed by 2 bytes containing the value.

3.1.9 ITEM TYPE 08 - RELOCATABLE LOCATION

This item type specifies a relocatable location value to be used with a following data item. The item type code is followed by 2 bytes containing the value which is to be added to the load module base address.

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3.1.10 ITEM TYPE 09 - ENTRY POINT DEFINITION

This item type defines the value of a symbolic entry point name. The item type code is followed by 10 bytes containing one to 10 ASCII characters left justified with blanks appended as necessary. The location value specified by a preceding item type 07 or 08 is assigned to the symbolic name.

3.1.11 ITEM TYPE 0A - EXTERNAL REFERENCE

This item type specifies the external name in an external reference chain. The item type code is followed by 10 bytes containing a one to 10 character ASCII symbolic name appended with blanks as necessary followed by 2 bytes containing a relative offset value. The location value specified by the previous item type 07 or 08 is the location of the previous link address. The offset value is to be added to the value of the symbolic name and the sum placed in the linked locations.

3.1.12 ITEM TYPE 0B - INTERNAL 16-BIT LINK

This item type specifies an internal 16-bit reference chain. The location specified in the previous item type 07 or 08 is the location of the previous link address and the value of the current location is to be placed in the linked locations. The item type code is followed by two bytes containing the offset value.

3.1.13 ITEM TYPE 0C - INTERNAL 8-BIT LINK

This item type specifies an internal 8-bit reference chain. The location specified in the previous item type 07 or 08 is the location of the previous link address and the value of the current location plus the offset is to be used to calculate the displacements for the linked locations. The item type code is followed by two bytes containing the offset value.

3.1.14 ITEM TYPE 0D - VARIABLE LENGTH DATA

This item type specifies one or more words of absolute data which are to be placed in core starting at the current location. The item type code is followed by one byte containing the number of words followed by two or more bytes where the number of bytes is equal to twice the count. The maximum count value is 36₁₀.

3.1.15 ITEM TYPE 0E - TRANSFER ADDRESS

This item type specifies a transfer address for program execution. The location value specified in a previous item type 07 or 08 is the address for transferring control to ^{the} program.

3.1.16 ITEM TYPE 0F - PROGRAM NAME

This item type specifies a program name for a load module. The item type code is followed by 10 bytes containing a left-justified program name. Blanks are appended as necessary. If this item type appears in a load module, it must be the first in the object text.

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3.1.17 ITEM TYPE FF - END OF LOAD

This item type specifies the end of all object text for the load module.

3.2 REFERENCE CHAIN STRUCTURE

A reference chain consists of one or more linked locations whose contents are determined at load time. There are three types of chains: an external reference chain, a 16-bit internal reference chain, and an 8-bit internal reference chain.

3.2.1 EXTERNAL REFERENCE CHAIN

Each location in an external reference chain contains the address of the previous location in the chain. The first location in the chain contains the absolute value zero while the last location in the chain is defined by item type 0A. In the object text, the pointer values can be a mix of relative and absolute addresses depending on whether the location being pointed to is relocatable or absolute. The only location that always has an absolute value is the first.

The chain is resolved by replacing each pointer with the value of the mnemonic name plus the offset starting with the last location and ending with the first.

3.2.2 INTERNAL 16-BIT REFERENCE CHAIN

The internal 16-bit reference chain is identical to the external reference chain except that item type 0B is used to define the last location in the chain.

3.2.3 INTERNAL 8-BIT REFERENCE CHAIN

The internal 8-bit reference chain consists of locations which have the displacement from the previous location in the rightmost or least significant 8 bits. The first location has a displacement of zero and the last location is specified by an item type 0C. The chain is resolved by replacing the displacements in each location by the difference between the address of the location and the address value specified by item type 0C.

3.3 TEXT EXAMPLE

The previous sections have listed the various types of data items that will appear in the object text record. The following example is intended to provide the user with a better understanding of the use of the individual data items. Figure 1 is a sample output from a relocatable assembly. Figure 2 is the object text that would be generated by the assembler.

The first item on the record is D2₁₆ (ASCII 'R') indicating to the loader that this is a relocatable load module. An absolute load module would be headed by D1₁₆ (ASCII 'Q'). The next two bytes are the record's sequence number starting at 0001. The sequence number is followed by the program name. Ten bytes are allocated for this purpose. Note that in this case, only seven bytes were used. The blank character A0 was used to fill out the remaining three bytes.

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The label 'EXAMPLE' is defined in the assembly level code to be an entry point with the same value of the location counter as 'START'. The location counter, that is, the value of 'START' is next written onto the load module. Note that it is a relocatable item, the actual value being defined by the loader. 'EXAMPLE' again appears on the load module, this time carrying an entry point definition item type code. Although this may appear redundant, this is not the case. In a module with multiple entry points, all entry point names would appear just after the program name. The actual entry point definitions would not appear until they were encountered in the program sequence. The list of entry point names is used to resolve external references without loading the complete module. The entry point definitions are relocatable items defined at load by the location counter and offset from the module head.

The first absolute data item is the object code for the load accumulator instruction. The code is totally independent of memory location. The data location defined by the label TWO is relocatable.

The remaining code is fairly obvious with item type code 'FF' indicating the end of the load module. If a multiple record module were required, the end of a record would be indicated by '00'.

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LISTING LOCATION	LISTING DATA	LINE NUMBER			
		0001		PROG	EXAMPLE
		0002	EXAMPLE	ENT	START
0000R	104C	0003	START	LDSA	(=TWO)
0001R	0003R				
0002R	B800	0004		HALT	
0003R	0002	0005	TWO	DATA	2
	0000R	0006		END	START

FIGURE 1

ASSEMBLED RELOCATABLE PROGRAM

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D2	Record type code	00	Entry point location 0000
		00	
00	Sequence number		
01		09	Entry point definition item type code
0F	Program name item type code	C5	E
C5	E	D8	X
D8	X	C1	A
C1	A	CD	M
CD	M	D0	P
D0	P	CC	L
CC	L	C5	E
C5	E	A0	
A0		A0	
A0		A0	
A0		05	Absolute data item type code
01	Entry point item type code	10	LDSA (P*)
C5	E	4C	
D8	X		
C1	A	06	Relocatable data item type code
CD	M		
D0	P	00	=TWO
CC	L	03	
C5	E		
A0		05	Absolute data item type code
A0			
A0		B8	HALT
08	Relocatable location item type code	00	
		05	Absolute data item type code
		00	2
		02	
		08	Relocatable location item type code
		00	START
		00	
		0E	Transfer address item type code
		FF	End of load item type code

FIGURE 2

SAMPLE LOAD MODULE

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APPENDIX I

OBJECT CODE ITEM TYPES

- 00 - Null Item (1 byte)
- 01 - Entry Point Name (9 bytes)
Name - 8 bytes left justified
- 02 - Absolute Program Origin (3 bytes)
Location - 2 bytes
- 03 - Relocatable Program Origin (3 bytes)
Location - 2 bytes
- 04 - Fill Data (5 bytes)
Word Count - 2 bytes
Data - 2 bytes
- 05 - 16-bit Absolute Data (3 bytes)
Data - 2 bytes
- 06 - 16-bit Relocatable Data (3 bytes)
Data - 2 bytes
- 07 - Absolute Location (3 bytes)
Location - 2 bytes
- 08 - Relocatable Location (3 bytes)
Location - 2 bytes
- 09 - Entry Point Definition (9 bytes)
Name - 8 bytes
- 0A - External Link Pointer (11 bytes)
Name - 8 bytes
Offset - 2 bytes
- 0B - Internal Link Pointer 16-bits (3 bytes)
Offset - 2 bytes
- 0C - Internal Link Pointer 8-bits (3 bytes)
Offset - 2 bytes
- 0D - Variable Length Data (2 x Count + 1 bytes)
Word Count - 1 byte
Data - 2 x Count bytes
- 0E - Transfer Address (1 byte)
- 0F - Program Name (9 bytes)
Name - 8 bytes
- FF - End of Load Module (1 byte)

10 - 16 Bit Relocatable Add. (3 bytes)
Address - 2 bytes11 - External Byte Ref (11 Bytes)
Name - 8 Bytes
Offset - 2 Bytes